PROBLEMS IN AGEING *NOTOTHENIA ROSSII MARMORATA*

by

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ABSTRACT. – Age determination was made on *Notothenia rossii marmorata* from South Georgia and South Shetland by means of scales , otoliths and bones. A method using the distribution of sclerites (circuli) is described.

RÉSUMÉ. – La détermination de l'âge de l'espèce *Notothenia rossii marmorata* des îles Georgie du Sud et Shetland du Sud a été faite au moyen des écailles, des otolithes et des os de la ceinture pectorale. Une méthode utilisant la distribution des circuli est décrite : elle permet de définir avec précision les annuli successifs.

Two sets of questions are connected with ageing fishes. One aspect is more theoretical and pertains to the reducible interpretation of the age marks of fishes. The other is more technical and pertains to the identification of an appropriate method for the processing of these age marks, where funding and time set clear limits. Thus methods are needed which allow for the rapid processing of large numbers of fishes.

I have attempted to age *N. rossii marmorata* by scales, otoliths and bones.

AGEING BY MEANS OF SCALES

The biggest scales occur on the fishes' flanks. The biggest scales are best for the age interpretation because in old fishes, the outer annuli lie very close together and often merge in smaller scales which means that the result will be too low. Because of the very high percentage of regenerated scales, a large quantity (up to 100 in big old fishes !) has got to be taken. Scale reading was done by means of a scale reading apparatus which had a screen of a diameter of at least 30 cm, which allows a magnification of 20 or 50 times. (At the magnification of 50 times, only parts of the scales become projected on the screen). Preliminary processing of the

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scales consists of removing epidermic remains, of selecting 10 to 12 appropriate scales of each fish (big scales with a well structured original center ; a dark background is useful for finding them out), and of placing these, just with a tiny drop of water, between two glass mounts, permanently held together by adhesive tape around their ends. The mounts were marked with the fishes' key numbers. When drying, the scales normally stick to the glasses because of some protein remains. Moreover, they get pressed between the mounts, if the adhesive tape is turned tightly around the ends of the mounts. So they do not get dislodged.

This method is quite time consuming because of the selection of appropriate scales from a large number of replacements. On the other hand, this time gets savedwhen one is ageing, because the scales, which have dried between the mounts in the meantime are nicely flat and one can compare the 10 or 12 scales from the fish in a very short time. Besides, the results of ageing are easily reproducible.

Removing the epidermic remains from the scales often presents a problem. Scales freshly removed from fishes can be put for a week in a weak detergent solution, after which the remnants of the skin can be easily washed off in a sieve under running water. In the case of some material used here, however, the scales had been put in paper envelopes in which the epidermic remains had dried up and thoroughly attached themselves to the scales. Even after a period of more than one week in detergent, these scales could not always be cleaned. After this time a decay process often initiates which affects the scales badly. This decaying process can start already in the paper envelopes in the case that these have not been laid out for drying after putting the fresly removed scales in them.

These difficulties were not observed in scales which had been kept together with the otoliths in little glasses (10 ml) with pure glycerine. Later, these could be cleaned easily under running water, and showed no damage even after 9 months in glycerine.

The following questions are associated with the interpretation of scale structures.

1) Which structures may be considered to represent annuli ?
2) Where is the first annual ring ?

In the present investigation it was assumed that hatching occurs at the end of the southern winter, in October/November (Shcherbich, 1975). Thus any fish passing through an antarctic winter completes a full year of life.

The scales of *N. rossii marmorata* display both wide and narrow sclerite structures. If these are belonging to annuli, it must be improved that these slerites are arranged according to a clear periodic pattern. In order to demonstrate this pattern the scales of 100 fjord-fishes from South Georgia were measured, and the sclerites counted. Transparent millimeter paper was used, and the narrow sclerites were drawn, starting from the center of the scale to the anterior edge (Fig. 1). It appeared that the narrow sclerite structures are distributed in a clear pattern, with the zones of high sclerite density appearing conspiciously periodical. The number of rings fitted well with the length distribution of the fjord-fishes. Thus it may be supposed that they represent annual checks. – False checks were very rare. They can be easily identified because they do not appear on all scales of one fish and because they do not fit into the pattern described above (Fig. 1). The size of the scales is irrelevant for these considerations because the annual checks are sufficiently wide apart in case of these young fishes (Fig. 2, Table 1).

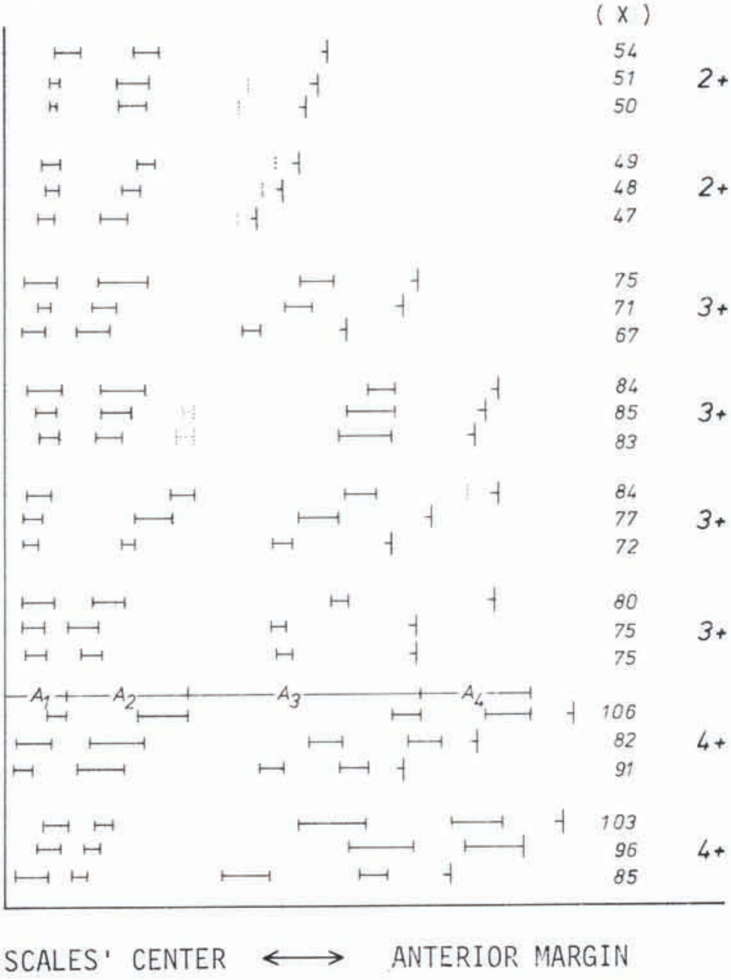


Fig. 1. – Graphical method for the identification of annuli showing the periodicity of the scale pattern. Measurements of scales are done on transparent millemeter paper. The left margin represents center of scale. Numbers on the right side give the sum of sclerites (x) and the age. Three different-sized scales are demonstrated per animal.

A_1 - A_4 : annuli

├─┤: width of winter rings

.....┆: secondary srtuctures

──┤: margin of scale

The identification of the first annulus can be based only on adequate knowledge of the young stages. Reported observations on larvae and young fingerling stages are still scarce. In the material used here, a fingerling of *N. rossii marmorata*, caught in the end of March 1976, had still no scales. Its total length was 4 cm. This small fish would have had produced its first scales with sclerite structures not before the southern winter or even the spring. Later, one year would have had to be added to the age estimated from the sclerite structures alone. Other fingerlings, however, caught at approximately the same time as the fingerling mentioned above, measured 6 to 7 cm and had fully developed scales. Thus, possibly the 4 cm finger-

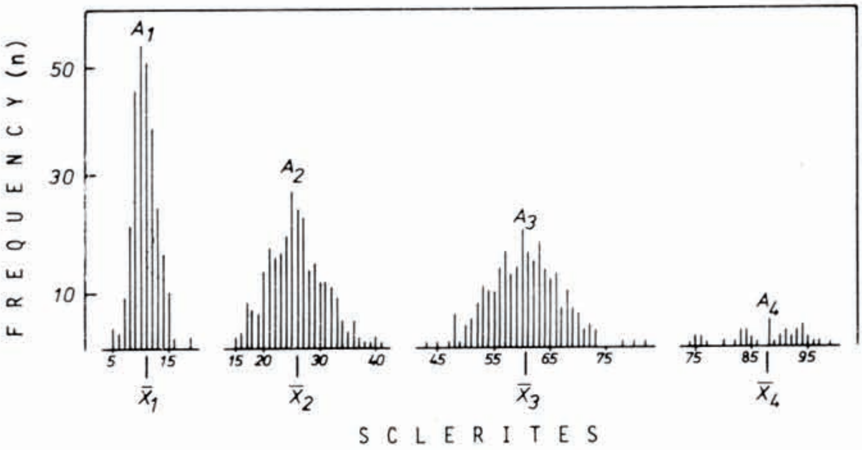


Fig. 2. – Sclerite distribution among the annuli on 280 scales of 100 fjord-fishes, caught at South Georgia, Feb. 1976. See also caption of Table I.

Table I. – a) number of sclerites counted from the scale center to the end of annulus ; b) number of sclerites from the beginning to the end of the annulus. – Generally 3 scales of different size were examined from each animal which explains the three maxima of the 4th annulus (A_4). These sclerite countings also confirm the periodicity of the scale pattern, and help to differentiate annuli from secondary structures.

A_1 - A_4 : 1st to 4th annulus
← x → : number of sclerites
$\overline{x}$: mean
s : standard deviation
n : number of examined scales

	a) A_1	A_2	A_3	A_4	b) A_1	A_2	A_3	A_4
n	280	280	270	42	280	280	270	42
← x →	4-18	15-41	43-82	74-90	4-18	5-31	19-54	17-34
$\overline{x}$	9,78	25,86	60,44	87,50	9,78	16,07	34,83	26,77
s	2,16	5,07	6,27	6,68	2,16	4,93	5,79	4,26

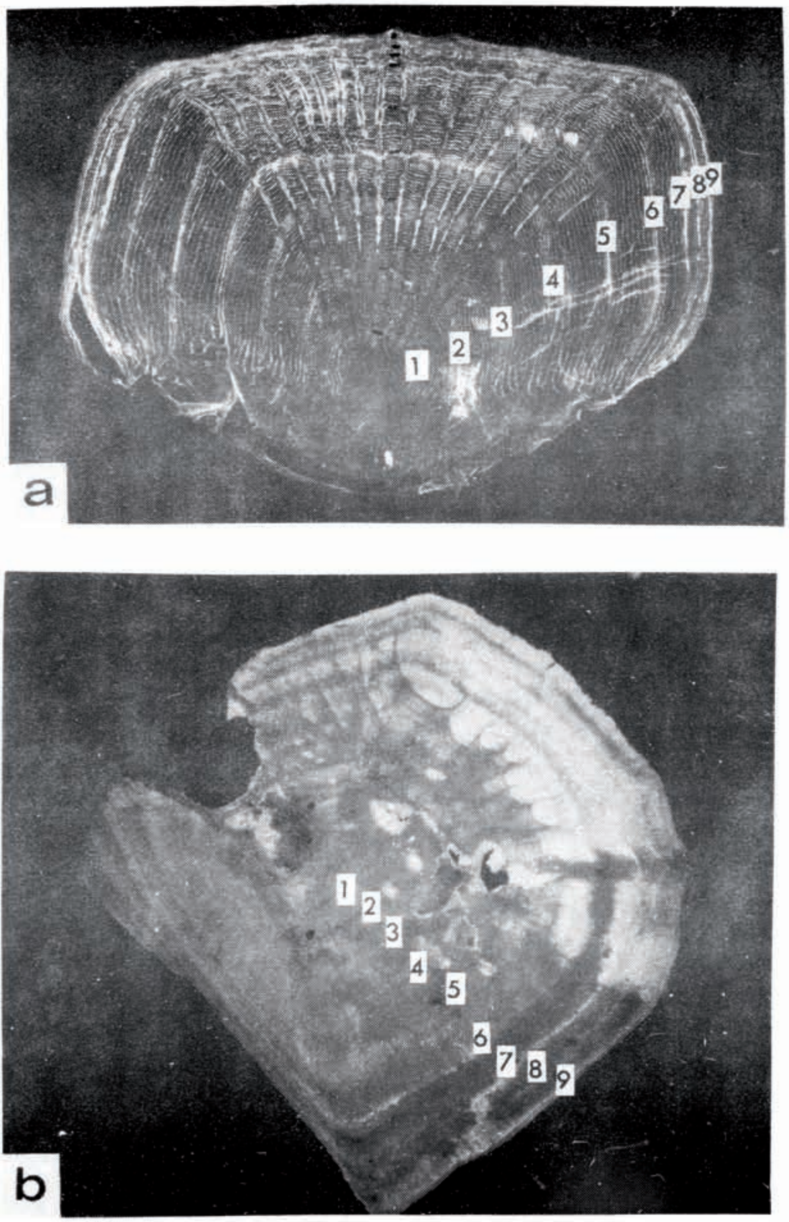
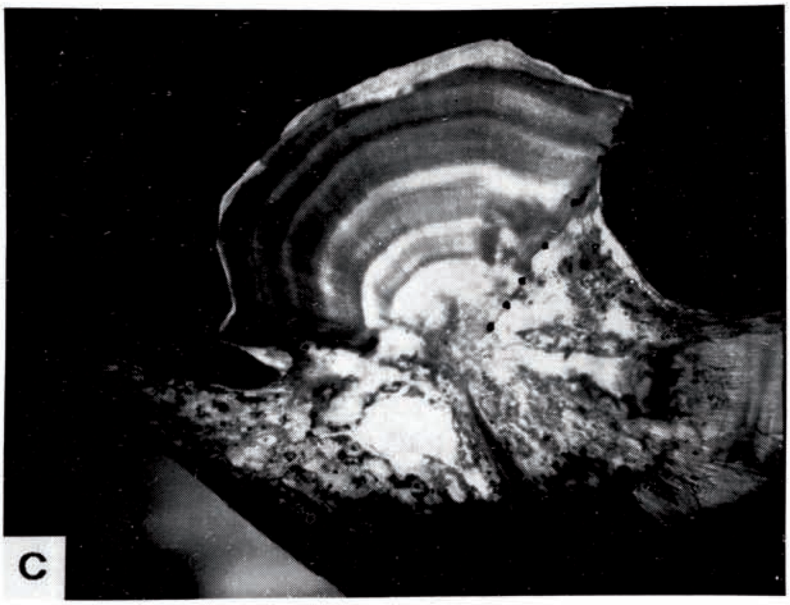


Fig. 3 a-c. – Scale, scapula and radial of a 50 cm long male of *N. rossii marmorata*, caught near the South Shetlands in February, 1976. 9 annuli can be counted in each of the photographs.



ling was simply lagging behind the others. – This example shows that the interpretation of the first annulus is still open.

The older fish may be grouped in two different types according to the first checks occuring at the center of the scales :

A. The first two checks are situated very close together and can hardly be told apart.

B. The first two checks are wide apart.

Near South Georgia only 30 % of the caught fishes belong to group A, while near the South Shetlands over 60 % belong to this group. If these structures are annual checks, it may be assumed that these fishes had a pelagic phase that lasted two summers (Shcherbich, 1975 ; Freytag, 1979).

Fig. 3a shows a scale of a nine year old adult, 50 cm long. This allows for the identification of several phases in the life history of this fish :

1. Fingerling stage (first and sometimes second year of life, according to Group B or A)
2. Fjord-fish stage with accelerated growth up to the 4th or 5th year of life
3. Sea-fish stage with decreasing growth rate indicated by the smaller distances between the outer annual checks of the scale.

From the 8th year on, the distance between the rings may become so small that these cannot be distinguished from each other. The scales are then of varying thickness and give an impression as if the edges had been resorbed. This may possibly be explained by resorption of calcium from the scales as described by Simkiss (1973).

An interesting fact is that the legibility of the scales seems to vary widely between stations. At some stations all the seafishes had globular structures in that area of the scale corresponding to the fjord-fish stage. At other stations the fish had scales with almost invisible annual structures (e.g. east of South Georgia). A station near Elephant Island yielded fishes whose scales were extremely easy to read. These observations suggest that these fish do not undertake wide migrations.

Table 2 to 4 show the results of ageing by means of scales of fishes from the German Antarctic Expeditions 1975/76 and 1977/78.

Table 2. – South Georgia, March/April 1976

Length	Age groups															
(cm)	5+	6+	7+	8+	9+	10+	11+	12+	13+	14+	15+	16+	17+	18+	19+	Σ
39	1															1
41																-
43	4	1														5
45	1	4	2													7
47		1	3													4
49		2	14	2												18
51			11	9												20
53			11	14	1											26
55			2	14												11
57			4	10	5											19
59				3	3											6
61				1		1										2
63					2	2										4
65					2	3										5
67					1			1								2
69						1										1
71																-
73																-
75																-
77																-
79											1					1
Σ	6	8	47	48	14	7	-	1	-	-	1	-	-	-	-	132
Ī	42,7	46	51	54,2	59,9	64,4		67			79					

Table 3. – South Shetlands, Jan./Feb. 1976

Length	Age groups																
(cm)	4+	5+	6+	7+	8+	9+	10+	11+	12+	13+	14+	15+	16+	17+	18+	19+	Σ
35		1															1
37		1															1
39		13	3														16
41		16	28	3													47
43		4	46	9	1												60
45			47	36	1												84
47			18	39	9		1										67
49			4	20	7	2	2										35
51			1	7	21	7	1										37
53				1	16	12	7	1									37
55				3	10	10	10		1								34
57				1	7	6	7	3									24
59						1	5	3									9
61					1	3	3	5									12
63						3	2	4									9
65						1		1	3	1							6
67																	
69								1									1
71									1	1							2
Σ		35	147	119	73	45	38	18	5	2							482
Ī		40,2	43,9	46,9	51,8	55,1	55,8	60,7	64,2	68							

Table 4. – South Shetlands, Jan./Feb. 1978

Length (cm)	Age groups 4+	5+	6+	7+	8+	9+	1o+	11+	12+	13+	14+	15+	16+	17+	18+	19+	Σ
35	1	2															3
37		4		1													5
39	1	5	5	4													15
41		1	7	9	1												18
43		2	13	13			1										29
45			5	34	6	1											46
47			5	43	13	1											62
49				35	9	4											48
51				23	24	6	3										56
53				3	11	9	3										26
55					5	10	10	6	2								33
57					2	7	4	2	2								17
59						4	9	3	5	2							23
61						1	1	8	7	1	3						21
63							2	2	8	2	1	2	1				18
65								4	1	3	5	1					14
67									1	5	4	2	2				14
69								1		5	1	3	2	2			14
71									1	3			1	1			6
73									1	3	2		1	2			9
75										1			2				3
77															1		1
79																1	1
81																1	1
Σ	2	14	35	165	71	43	33	26	28	25	16	9	9	5	1	2	484
$\bar{L}$	37	38,6	42,9	46,8	50,1	53,9	56,1	60,2	61,6	67,5	65,9	65,4	69,9	71	77	80	

AGEING BY MEANS OF OTOLITHS

The otoliths of *N. rossii marmorata* are very small and display various structures. Attempts were made to improve their readability by means of xylene, methyl benzoate, monobromenaphtalene. The method of sawing the otoliths (Rauck, 1975) was also used without any marked success. The latter method in which the otolith is embedded in polyester, and then sawed into thin slices (which are subsequently polished) is far too time consuming by the specific case of *Notothenia* which has very fragile otoliths. A better method seemed to read the otolith kept in pure glycerine under polarized light. (Otoliths which had been dried have to be heated up to 150° C in glycerine so they become transparent again). Photographs, made of these otoliths under polarized light show even clearer rings than can be perceived by eye. Reading in glycerine finally has the advantage of showing a number of rings generally corresponding well with the number of rings in scales. This was not the case with xylene and other solutions. The method according to which the otoliths become embedded in black polyester resin and are sawn afterwards (Bedford, 1977) has yet to be tested.

AGEING BY MEANS OF BONES

For the ageing of fish all bones can be used which only increase in area during the fish's growth. Other bones must be sawn through their nucleus which is often complicated and time consuming. Some bones, e.g. the operculum of *N. rossii marmorata* are often unreadable because of resorption and redisposition of bone material. Appropriate bones for ageing are the scapulae and the big radials because their growth increments are flat and generally display structures which often can be identified by the naked eyes. The outer annuli are well structured even in older fish and therefore these bones represent good complements to ageing by scales. It may be recalled that ageing by means of scales is somewhat problematic in very old fishes. On the other hand, the first rings of these bones are sometimes difficult to identify.

Preparation methods. The pectoral bones of both sides were roughly cutted from the fish, treated with boiling water, so that the muscles and the fin rays were easily removed, then the bones were put in temperated water to let the remnants of meat decay during one or two weeks. Some detergent was added to the water to absorb the oily components of the meat which turn the bones yellow. After the time of maceration, the bones were cleaned under running hot water and shortly put in alcohol for desinfection. Afterwards they were stored dry in little pots.

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